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Does financial development contribute to SAARC'S energy demand? From energy crisis to energy reforms

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A B S T R A C T

SAARC members urgently need to secure sustainable energy supplies at affordable prices. Alarmingly high oil prices in the face of ever increasing energy demand have resulted in severe pressure on resources of SAARC members. The objective of this study examine the relationship among energy consumption, economic growth, relative prices of energy, FDI and different financial development indicators (i.e., broad money supply, liquid liabilities, domestic credit provided by banking sector and domestic credit to private sector) in the panel of selected SAARC countries namely Bangladesh, India, Nepal, Pakistan and Sri Lanka over a period of 1975–2011. Panel cointegration test suggest that the variables are cointegrated and have a long-run relationship between them. In addition, three different panel data methods i.e. pooled least square, fixed effects and random effects have been used to test the validity of the "energy-growth nexus via financial development" in the SAARC region. Specification tests (i.e., *F*-test and Hausman test) indicate that the fixed effect model considered as the best model to examine the relationship between energy and growth determinants, this implies that variables are apparently influenced by country effects only. The fixed effect model shows that there is a significant relationship among energy consumption, economic growth, FDI and financial development (FD) proxies, however, FD indicators has a larger impact on increasing energy demand, followed by GDP per capita and FDI. Therefore, it is concluded that there is a trade-off between the energy and growth variables in SAARC region, collective efforts is required to transform SAARC region from an energy-starved to an energy efficient region.

Contents

Abbreviations: ADB, Asian Development Bank; ADF, Augmented Dickey Fuller; ASEAN, Association of Southeast Asian Nations; DBC, Domestic credit provided by banking sector; DPC, Domestic credit to private sector; EC, Energy Consumption; FDI, Foreign Direct Investment; GDP, Gross Domestic Product; IPS, Im, Pesaran and Shin; LLC, Levin, Lin and Chu; LSDV, Least Squares Dummy Variables; M2, Broad Money Supply; MW, Mega Watt; PP, Philips Perron; RPRICES, Relative Prices; SAARC, South Asian Association for the Regional Cooperation; SAPTA, South Asian Association for Regional Cooperation; SEC, Security Exchange Commission; SHRDC, SAARC Human Resource Development Centre; UNCTAD, United Nations Conference on Trade and Development

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1. Introduction

SEC [45] reported that about 22% of the world is still living without access to electricity, mostly in rural areas far away from the national grid. According to the International Energy Agency about 85% of these people live in rural areas in developing of Sub Saharan Africa and South Asia. The International Energy Agency assesses that even in 2030 about 1.4 billion people, mostly in Africa and South Asia, will not have access to electricity.

The governments of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka on 8th December 1985 established the South Asian Association for Regional Cooperation (SAARC) formally adopting its charter providing for the promotion of economic and social progress, cultural development within the South Asia region emphasizing on collective self-reliance. SAARC also provides for friendship and cooperation with other developing countries. SAARC accepted Afghanistan as its member in 2007. It primarily focuses on acceleration of the process of economic and social development through joint action in the agreed areas of cooperation [49].

SAARC members urgently need to secure sustainable energy supplies at affordable prices. Alarmingly high oil prices in the face of ever increasing energy demand have resulted in severe pressure on resources of SAARC members. It threatens to slow down economic development, fuel inflation, increase poverty, and bringing socio-political instability in the region [42]. The energy deficient South Asian region depends heavily on imports due to its inability to produce required oil and gas and generate enough electricity to meet its needs. Estimates indicate three times greater energy needs for the region in next fifteen to twenty years [50].

Achieving durable peace in the region calls for energy cooperation among SAARC countries. Dhaka declaration in 2005 resulted in establishing SAARC Energy Centre to help establish an Energy Ring in South Asia which started working on 1st March 2006 in Islamabad, Pakistan. For meeting its energy demands, SAARC Energy Cooperation Program aims for economic prosperity of South Asia. SAARC Energy Centre is working to turn development challenges into opportunities. It is a platform to tap potentials of cooperation in energy sector including developing hydropower, renewable and alternative energy, promoting technology transfer, energy, energy trade, energy conservation and efficiency improvement in the region b bringing together officials, experts, academia, environmentalists and NGOs etc. SEC [45]. Table 1 shows the energy profile of SAARC countries as compared to other countries/region.

Transforming to energy efficient from energy starved region, SAARC countries must cooperate and collaborate to overcome 50,000 MW electricity shortfalls [48]. At the South Asian Association for Regional Cooperation (SAARC) level, a process aiming at energy cooperation was started in 2000. The main milestones achieved so far are listed in Table 2.

Foreign Direct Investment (FDI) plays vital role in the economic development by contributing in GDP growth and bringing foreign funds, advanced technologies and skills to the host countries. FDI indicates long-term interest in a local entity. Flow of FDI to a country takes into consideration different macroeconomic factors, policies of that government, and long term corporate strategies of multinational corporations [33].

Regional integration can bring economic development in number of countries irrespective of size and the growth. Only deeper cooperation can exploit such potential. However, a number of challenges restrict this region to tap its potential. Though, the very nature of its

Table 1
Energy profile in SAARC and other countries/region.
Source: SEC [44]. ACGR, kWh and yr represents annual change in growth rate, kilo watt hour and year respectively [35].

Country/Region	Energy use kgoe/capita/yr	ACGR in last 10 years	Electricity use kWh/capita/yr	ACGR in last 10 years
SAARC	514	2.5%	517	4.1%
USA	7051	−1.2%	12,914	−0.3%
EU	3536	−0.4%	6592	0.7%
Brazil	1243	1.4%	2206	1.9%
Malayasia	2391	3.0%	3614	3.3%
China	1695	6.9%	2631	11.2%
World	1788	0.9%	2803	2.0%
Comparison of electricity profiles of South Asian countries (2012)				
Countries	Electricity installed capacity (GW)	Electricity generation (000, GWh)	Distribution losses (Percent)	Per capita consumption (KWh)
India	210.38	912.25	29.25	634
Pakistan	28.77	94.82	22.01	512
Bangladesh	7.28	41.25	13.27	178
Nepal	0.98	3.85	19.98	112
Sri Lanka	3.25	11.28	12.01	498

underdeveloped economy demands integrated efforts of SAARC members to overcome such huge challenges [12]. Under the broader framework of SAARC, South Asian Preferential Trade Agreement (SAPTA) signed in 1995 was instrumental speeding the process of economic integration in South Asia. SAPTA is however viewed as interim platform for a greater economic integration in South Asia. Many believe regional integration can enhance FDI flow and economic development of the region. This will surely pave the way for most efficient use of South Asian resources through economies of scale, value addition, employment generation, and diffusion of technology [41]. Though the regional integration did not enhance the SAARC share in world trade but it has increased FDI inflows and trade share in Asia and world respectively [4]. Table 3 shows the mechanisms of the impacts of regional economic integration on FDI.

South Asia is perchance one of the least integrated developing region of the world. Liberalization of trade still needs effective efforts. There are numerous barriers, among highest in the world, to trade and investment between neighboring countries due to lack of economic integration against its real potential. FDI as percentage of GDP have been not only smaller to this region in comparison to rest of the regions such as ASEAN world but its pace of increase has also been lesser [53]. Generally, foreign institutions do not counter barriers in financially integrated regions. Financial integration paves path for increased investment, and access to capital, decreased funding costs, stabilized macroeconomic policies, all of which help regional stability, and economic growth. Financial integration makes efficient allocation of resources and higher economic growth possible [7]. Primarily, 1990s saw financial reforms in most of the South Asian countries except Sri Lanka and Nepal. Whereas Sri Lanka initiated financial reforms much earlier, Nepal could do the same only in 2002. South Asia had the advantage of learning pros and cons from its predecessors in reforms such as Latin American countries which experimented with big bang liberalization measures and the transition countries. Hence South Asia was cautious in its reforms while attempting allocative efficiency and increasing profitability of financial sector [32].

Financial integration in Asia lags behind trade integration. Financial markets in Asia have greater integration with global markets than among themselves. Though after global crisis of 2008/09 regional integration is believed accelerating, its still has significant sub regional variation [3]. Table 4 shows the banks' overhead costs, return on assets, and interest margin based on bank ownership. Government owned banks, in sharp contrast to the foreign owned and private sector banks, not only have the highest overhead costs but also their returns on assets and interest margins are the lowest among all the bank groups.

Magnificent Asia, with some of the world's richest and dynamic economies, shares 36.6% of global Gross Domestic Product (GDP), 25.4% of earth's land mass, and 56.2% of the world population (Table 5). Along with this, its 2/3rd share of world's overall poor people reflect true diversity of Asia in terms of economic development.

The discussion above strongly signifies the relationship among financial development indicators of SAARC countries, their FDI inflows, energy consumption, economic growth, and relative prices. The study attempts analysis of statistical relationship between energy and growth factors using secondary data from 1975–2011 of financial development indicators of five SAARC countries i.e., Bangladesh, India, Nepal, Pakistan, and Sri Lanka.

Table 4
Bank profitability, efficiency and margins in South Asia.
Source: ADB [1].

Bank ownership	Return on asset	Overhead costs/ total costs	Overhead costs/total costs interest margin/total assets
Government	0.54	2.64	2.69
Foreign	1.68	2.07	3.43
Private	1.04	2.44	3.08

Table 2
Energy cooperation under SAARC.
Source: SAWTEE [43].

January, 2000	Technical committee on energy
January, 2004	Specialized working group on energy
1st October, 2005	First meeting of energy ministers, Islamabad: formation of expert group on energy conservation and efficiency and roadmap for SAARC region
January, 2006	Establishment of the SAARC energy centre in Islamabad
5th March, 2007	South Asia energy dialog: recommendations to promote cooperation
January, 2009	Concept of "Energy Ring", Colombo
April, 2009	Fifth meeting, Working Group: Establishment of expert groups on (a) oil and gas, (b) electricity, (c) renewable energy, (d) technology and knowledge sharing
April, 2010	Concept of SAARC market for electricity in the 16th SAARC Summit declaration

Table 3
Mechanisms of the impacts of regional economic integration on FDI.
Source: UNCTAD [53].

Mechanisms	**Effects on intraregional FDI flows**	**Effects on FDI inflows from outside the region**
Investment liberalization and/or protection provisions in regional agreements	Enables/encourages increased flows from regional investors per se, including existing third-country investors from outside the region	Enables/encourages increased flows from third-country investors not currently established inside the region
Trade and market integration provisions in regional agreements	Enables the reorganization of production at the regional level, including investments and divestments	Attracts new third-country Investment through enlarged markets, including within global value chains
Policy harmonization implicit in the implementation of regional agreements	Encourages investment through reductions in transaction costs and perceived risk	Enables/encourages increased inflows if harmonization encompasses investment regulations applicable to third-country investors
Broader pan-regional investment projects (e.g. infrastructure or research and development) made possible by, or integral to, regional agreements	Provides increased investment opportunities	Provides increased investment opportunities

Table 5
Basic economic indicators by region and sub-region.
Source: ADB [3].

	Share of world population % (2010)	Share of world GDP (%, PPP) 2011	Real GDP growth (%)		Per capita GDP (PPP)	
			Average 2000–2007	Average 2008–2011	US $ 2011	Average growth (%) 2000–2007
Asia	56.2	36.6	6.2	5.8	7,376	7.0
East Asia	22.5	23.5	6.3	5.9	11,896	7.7
Central Asia	1.2	0.7	10.3	5.9	6,396	9.8
Southeast Asia	8.7	4.2	5.5	4.5	5,476	6.0
South Asia	23.3	6.9	6.8	7.0	3,325	7.4
The Pacific and Oceania	0.5	1.3	3.4	2.0	29,623	3.5
European Union	7.2	20.1	2.6	0.0	31,607	3.6
North America	6.6	23.0	2.6	0.4	39,450	3.1
World	100.0	100.0	4.2	2.8	10,821	4.7

The objective of this study is to find out that existence of energy – growth nexus via financial development indicators in the SAARC countries. The more specific objectives are as follows:

- To empirically investigate the impact of economic growth, relative prices, FDI and financial development indicators on energy consumption, by using a panel cointegration framework in selected SAARC countries.
- To estimate whether energy and growth factors are apparently influenced by country specific effects / shocks, time specific shocks or both?

The paper is organized as follows: after introduction which is provided in Section 1 above, literature review is carried out in Section 2. Data source and methodological framework is explained in Section 3. The estimation and interpretation of results is mentioned in Section 4. Section 5 concludes the study.

2. Literature review

The heterogeneous context of different countries and regions of the world reflected diverse findings in different global studies on energy and growth. A SAARC based study, being more homogeneous in nature, finds collective efforts more fruitful to transform South Asia from energy-starved to an energy efficient region.

[25] opine that,

"..the stimulus for Asia's growth in the future will have to increasingly come from within. This makes regional economic cooperation all the more important to Asia's future growth prospects."

Malik and Janjua [30] found that financial crisis through trade channel rather than financial channel impacted the South Asian region. They were investigating the impact of financial crisis on economic growth and employment in three South Asian countries from 1972 to 2009. Hossain [18] found bidirectional short-run, and not long-run, causal relationship between economic growth and export values while investigating the dynamic causal relationship among economic growth, electricity consumption, export values and remittance for the panel of three SAARC countries using time series data from 1976 to 2009. Chary and Bohara [11] concluded that income and energy consumption together cause carbon emissions in four major SAARC countries. They were studying causal relationship between income, energy consumption, and carbon emissions. Pradhan [38] found unidirectional short run and long run causality from oil consumption to economic growth in Bangladesh and Nepal, from electricity consumption to economic growth in Pakistan and Sri Lanka, from economic growth to oil consumption in India and Sri Lanka, and from economic growth to electricity consumption in India and Nepal. The study was exploring the nexus between energy consumption (oil and electricity) and economic growth in five SAARC countries from 1970 to 2006. In addition, the study found bidirectional causality between electricity consumption and economic growth in Bangladesh and between oil consumption and economic growth in Pakistan. Hossain and Saeki [19] investigated the dynamic causal relationship between electricity consumption and economic growth. It used time series data of panel of South Asian countries from 1971 to 2007. The Granger causality tests' results indicate unidirectional causality from economic growth to electricity consumption in India, Nepal, and Pakistan, and vice versa in Bangladesh. Iran and Sri Lanka had no causal relationship. The following hypothesis has been drawn on the basis of above literature i.e.,

H1. Energy consumption stimulates the growth indicators (i.e., GDP per capita, relative prices, and FDI) in the selected SAARC countries.

Shahbaz et al. [47] found positive impact of capital export, energy consumption, financial development, imports, and international trade on economic growth in China from 1971 to 2011. Unidirectional and bidirectional Granger causality was found from energy consumption to economic growth; and between financial development and energy consumption, and between trade and energy consumption respectively. Pradhan [39] found short run and long run bidirectional causality between government spending and economic growth in five SAARC countries from 1970 to 2007 except Pakistan and Sri Lanka. Nguyen et al. [34] while investigating relationship between bank market power and revenue diversification in four South Asian countries (Bangladesh, India, Pakistan, and Sri Lanka) from 1998 to 2008 found banks with greater market power focus more on conventional interest income generating activities. However, diversifying across both interest and non-interest income activities help them more stabilize.

Kreishan and Sami [24] found positive impact of FDI and exports on economic growth in Jordon from 1970 to 2010. They found long run causality from exports and FDI to economic growth. Perera and Wickramanayake [37] found that both stock and bond returns were co-integrated implying common stochastic trends. The study was conducted in financial markets of four major South Asian countries i.e. Bangladesh, India, Pakistan, and Sri Lanka. Stock market was more integrated than the less developed and data deficient bond markets. ([40], p.1) argue that,

> "South Asian countries need to embark on a second round of "Look East" Policies (LEP2) to (i) link themselves to production networks in East Asia and (ii) develop production networks in manufacturing and services within their region. Such policies would allow both regions to benefit mutually and in a shared

manner not only from the static complementarities but also the dynamic complementarities".

Jayanthakumaran and Lee [22] studied the per capita convergence patterns of ASEAN and SAARC countries (a set of 5 each) from 1967 to 2005. The relative per capita income series of ASEAN-5, and not SAARC-5, were consistent with stochastic convergence and β convergence. The structural breaks linked with the world oil crisis and the Asian crisis strongly affected the convergence and divergence process in ASEAN-5. From the above discussion, the study hypothesizes that:

H2. Energy consumption stimulates the financial indicators (i.e., broad money supply, liquid liabilities, Domestic credit provided by banking sector and Domestic credit to private sector) in the selected SAARC countries.

South Asia faces great challenges of energy consumption, energy growth, and financial liberalization. The energy-growth nexus needs thorough analysis through financial development channel and to find out the inter relationship. In the subsequent sections, an effort has been made to empirically find out the relationship between energy and growth in the context of SAARC region.

3. Data source and methodological framework

In this study, we consider a balanced panel of selected South Asian Association for Regional Cooperation (SAARC) countries; namely, Bangladesh, India, Nepal, Pakistan and Sri Lanka over the period of 37 years from 1975–2011 are collected from *World Development Indicators* which is published by World Bank [54]. The data for energy consumption (i.e., kg of oil equivalent per capita); GDP per capita (current US$); relative price of energy to non-energy goods (measured by the ratio of the price index to the GDP deflator, annual %), foreign direct investment, net inflows (% of GDP); money and quasi money as % of GDP; liquid liabilities (M3) as % of GDP; domestic credit provided by banking sector as % of GDP and domestic credit to private sector as % of GDP has been taken for analysis.

The dependent and independent variables used in this study are listed in Table 6. Energy consumption is used as a dependent variable for the study while, independent variables are GDP per capita; foreign direct investment; relative energy prices, broad money supply, liquid liabilities, domestic credit provided by banking sector and domestic credit to private sector.

A simple theoretical model has been adopted to show energy-FDI-finance-growth nexus in selected SAARC countries is given in Fig. 1.

Fig. 1 show the five possible linkages between the variables i.e., (i) energy consumption to financial development, (ii) energy consumption top FDI, (iii) energy consumption to economic growth, (iv) FDI to energy consumption and (v) financial development to economic growth. Zeren and Koc [55] concluded that financial development causes the more efficient use of energy sources which lead to decrease costs of energy consumption per capita. Chtioui [13] argued the policy implications of the causality between the variables, as economic growth Granger cause energy consumption, it implies that energy conservation policies have little effects or no such effects on economic growth, however, energy consumption Granger cause economic growth shows that reducing energy consumption, through bringing domestic energy prices in line with market prices, could lead to a fall in income of the countries. According to ([52], p. 372),

> "Conceptually, the influx of FDI is inducing electricity consumption through the expansionary of industrialization, transportation and manufacturing sectors development while electricity is required to support the manufacturing process. Therefore, FDI could Granger cause electricity consumption or vice-versa".

It is imperative to recognize the essential determinants of energy efficiency for several reasons. Firstly, energy is a basic element in the production process and energy crisis can be unfavorable to economic development. Secondly, energy efficiency is a major factor for measuring the intensity of one economy's dependence on energy consumption. It is of great value to spotlight on enhancing energy effectiveness for Asia, who is facing pressing condition in terms of energy security, in order to evade the pressure of international oil price variation. For the moment, energy demand is also critical to the management of air pollution and greenhouse gas emissions since energy consumption, particularly the burning of fossil fuels is considered a principal cause of air pollution [8].

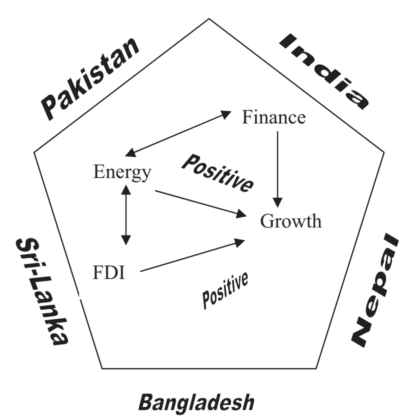

Fig. 1. Unified framework of energy-FDI-Finance-growth nexus in selected SAARC Countries.
Source: Self extract.

Table 6
List of variables.

Variables	Measurement	Symbol	Expected Sign	Data Source
Dependent variable				
Energy consumption	kg of oil equivalent per capita	EC		World Bank [54]
Independent variables				
GDP per capita	Current US $	GDPPC	Positive	World Bank [54]
Foreign direct investment, inflows	% of GDP	FDI	Positive	World Bank [54]
Relative energy prices	The ratio of the price index to the GDP deflator, annual %	RPRICES	Positive /Negative	World Bank [54]
Money and quasi money	% of GDP	M2	Positive	World Bank [54]
liquid liabilities (M3)	% of GDP	LL	Positive	World Bank [54]
Domestic credit provided by banking sector	% of GDP	DBC	Positive	World Bank [54]
Domestic credit to private sector	% of GDP	DPC	Positive	World Bank [54]

3.1. Econometric methodology

The study adopted the following sequential econometric modeling technique i.e.,

- Firstly, the study adopted Levin, Lin and Chu (LLC), Fisher-ADF, and Fisher-PP unit root test to check the unit root problem in the data set of each variable.
- After examining the unit root problem, the study employed Pedroni residual cointegration test to check the long-run relationship between the variables. For this purpose, four cointegration test has been performed i.e., Panel v-statistic, Panel rho-statistic, Panel PP-statistic and Panel ADF-statistic.
- Next, the study takes on the panel least square test to evaluate the significance between the variables.
- The study adopted two more econometric techniques i.e., panel fixed effect and panel random effect to absorb the country specific and time specific shocks in the region.
- Finally, the study used different *F*-tests and Hausman tests for signifying the econometric tests in the region.

In empirical and theoretical literature, there exist a few studies that explain the relationship among energy consumption, GDP per capita, FDI, relative prices and financial development indicators in the context of SAARC region. In this study, we employed the following three separate methods i.e., Pooled Least Squares (Common Constant Method), Fixed Effect [i.e., the Least Squares Dummy Variables (LSDV)] and Dynamic Model are used to test the validity of energy led growth; FDI led growth and finance led growth hypothesis in the selected SAARC countries during 1975–2011.

The general representation of the equation is as follows:

$$\ln(\mathrm{EC})_t = f\ \ln(\mathrm{GDPPC,\ RPRICES,\ FDI,\ M2,\ LL,\ DBC,\ DPC})$$

The general representation of the equation mentioned above is as follows:

$$\mathrm{Log}\,(Y_t) = C + \beta_{1t}\,\log(X_{1t}) + \beta_{2t}\,\log(X_{2t}) + \beta_{3t}\,\log(X_{3t}) + \beta_{4t}\,\log(\lambda^*{}_{4t}) + \varepsilon_t \quad (1)$$

where Y_t is the dependent variable; C is the intercept; β_t is the slope of the independent variables; X_t is the growth measures (i.e., GDPPC, RPRICES and FDI); λ_t is the financial development indicators (i.e., M2, LL, DBC and DPC); $T=1,\ 2\ldots37$ periods; $i=1,\ 2\ldots5$ countries; ε_t is the error term; β_1 is the coefficient of economic growth; β_2 is the coefficient of relative prices; β_3 is the coefficient of FDI; β_4 is the coefficient of financial development (FD) indicators; $*$, asterisk represents FD indicators separately regress on energy consumption and ε_t is the error term.

To incorporate country specific effects, a fixed effects model could take a form:

$$\ln(\mathrm{EC})_{it} = \alpha_{it} + \beta_1\ \ln(\mathrm{GDPPC})_{it} + \beta_2\ \ln(\mathrm{RPRICES})_{it} + \beta_3\ \ln(\mathrm{FDI}) + + \beta_4\ \ln(\mathrm{FD}) + u_{it} \quad (2)$$

where α_i is a country effects.

To incorporate both countries and time effects, random effect model take the form:

$$\ln(\mathrm{EC})_{it} = \alpha_0 + \alpha_i + \theta_t + \beta_1\ \ln(\mathrm{GDPPC})_{it} + \beta_2\ \ln(\mathrm{RPRICES}) + \beta_3\ \ln(\mathrm{FDI})_{it} + + \beta_4\ \ln(\mathrm{FD})_{it} + u_{it} \quad (3)$$

4. Empirical findings

To test whether each of the variables in a study containing a panel unit root, the panel unit root tests proposed by Levin, Lin and Chu (LLC), Fisher-ADF, and Fisher-PP tests have been applied on the data set. Table 7 reports these results.

The results show that FDI, RPRICES, M2, LL and DPC have a unit root at level while EC, GDPPC and DBC have a non-stationary at level, however, after taking first difference, these variables have become stationary. The results indicate mixture of order of integration; therefore, we applied the test of cointegration given by Pedroni [36]. Results are given in Table 8.

The result shows that in all four columns, first panel statistic is positive (i.e., v = 1.22, 1.80, 0.89 and 0.57) and rest of three panel statistics is negative (i.e., rho = −4.50, −2.25, −0.49 and −1.15; PP = −4.10, −3.49, −0.11 and −2.22 and ADF = −1.32, −3.90,

Table 7
Panel unit root tests.

Variables	Level			First difference		
	LLC	Fisher-ADF	Fisher-PP	LLC	Fisher-ADF	Fisher-PP
Ln (EC)	−0.645	2.955	3.013	−17.610*	110.836*	336.045*
Ln (GDPPC)	0.341	16.678	16.942	−18.286*	115.762*	110.782*
Ln (FDI)	12.500	93.918*	26.486*	−9.210**	90.753*	460.833*
Ln (RPRICES)	−4.252*	51.323*	62.472*	−18.590*	336.991*	919.343*
Lm (M2)	−1.901**	31.841*	33.453*	−8.062*	70.460*	81.500*
Ln (LL)	−10.194*	110.107*	300.964*	−8.345*	82.121*	113.734*
Ln (DBC)	−1.159	16.154	15.588	−7.879*	73.220*	78.607*
Ln (DPC)	1.107	24.567*	23.466*	−5.777*	69.780*	80.018*

Note:

* 1% Level of significance.

** 5% Level of significance.

Table 8
Pedroni residual cointegration test.

Pedroni (Engle-Granger based)	Ln (EC), Ln (GDPPC), Ln (RPRICES), Ln (FDI), Ln (M2)	Ln (EC), Ln (GDPPC), Ln (RPRICES), Ln (FDI), Ln (LL)	Ln (EC), Ln (GDPPC), Ln (RPRICES), Ln (FDI), Ln (DBC)	Ln (EC), Ln (GDPPC), Ln (RPRICES), Ln (FDI), Ln (DPC)
Panel v-statistic	1.22	1.80	0.89	0.57
Panel rho-statistic	−4.50	−2.25	−0.49	−1.15
Panel PP-statistic	−4.10	−3.49	−0.11	−2.22
Panel ADF-statistic	−1.32	−3.90	−0.19	−2.42

−0.19 and −2.42). On the basis of Pedroni test we can conclude that series are cointegrated and have a long-run relationship.

Then we used Pooled estimation of least square, fixed effect and random effect for estimating whether energy consumption and growth determinants is influenced by country specific effects/shocks, time specific shocks or both? The results of pooled least square are presented in Table 9.

The results of Table 9, column 1 show that relative energy prices and broad money supply has a positive and significant impact on energy consumption in selected SAARC countries, however, the intensity of their magnitude is different, as if there is one percent increase in relative energy prices and broad money supply, energy consumption increases by 0.107 percent and 0.548 percent respectively. The result concludes that sound and developed financial system attract investors, boost the stock market and improve the energy efficiency in the SAARC region. In Table 9, column 11, same results has been appeared on energy consumption, as this time another financial determinant i.e., liquid liability (LL) has a significant and greater impact on energy consumption as compared to the relative prices of energy i.e., 0.950 percent. In Table 9, column III, shows that both FDI and domestic credit provided by banks (DBC) has a significant impact on energy consumption, similarly, DBC (another proxy for financial development) has a greater impact on energy consumption as compared to FDI in SAARC region, as FDI contributes only 0.033 percent while DBC contributes to increasing demand for energy by 0.422 percent respectively.. The result suggests that an escalation in energy consumption lead to more economic and investment activities. This increases the demand for financial services that further hints to financial development [46]. In Table 9, column IV, shows that there is a positive and significant impact of FDI, relative prices and domestic credit to private sector (DPC) on energy consumption in SAARC region, however, this time also DPC (proxy for financial development) exerts the largest impact of 0.225 percent on energy consumption. The analysis shows that energy prices increase with FDI in the host countries whereas FDI increases with better growth chances [6]. In terms of the usual diagnostic statistics, the value of adjusted R-square for pooled OLS lies in between minimum 33.7 percent to maximum 54.8 percent variation of independent variables explained to the dependent variable. F-value is higher than its critical value in all four columns, suggesting an overall good significance of the estimated model. Therefore, fitness of the model is acceptable empirically.

Table 9
Pooled least square regression test dependent variable: ln $(EC)_t$.

Variables	Pooled OLS (1)	Pooled OLS (2)	Pooled OLS (3)	Pooled OLS (4)
Constant	3.057***	2.280***	3.573***	4.453***
ln $(GDPPC)_t$	0.082	−0.030	0.088	0.083
ln $(FDI)_t$	0.029	−0.011	0.033*	0.057***
ln $(RPRICES)_t$	0.107***	0.094***	0.057	0.078*
ln $(M2)_t$	0.548***	–	–	–
ln $(LL)_t$	–	0.950***	–	–
ln $(DBC)_t$	–	–	0.422***	–
ln $(DPC)_t$	–	–	–	0.225***
R-square	0.434	0.548	0.380	0.337
Adjusted R-square	0.421	0.538	0.366	0.323
F-statistics	34.562***	54.689***	27.638***	22.967***

Note:
*** Significance at 1% level.
* Significance at 10% level.

Table 11
Pooled random effect regression test dependent variable: ln $(EC)_t$.

Variables	Pooled random effect (1)	Pooled random effect (2)	Pooled random effect (3)	Pooled random effect (4)
Constant	3.057***	2.280***	3.629***	4.453***
ln $(GDPPC)_t$	0.082	−0.030	0.102*	0.083
ln $(FDI)_t$	0.029	−0.011	0.032*	0.057***
ln $(RPRICES)_t$	0.107***	0.094***	0.049	0.078*
ln $(M2)_t$	0.548***	–	–	–
ln $(LL)_t$	–	0.950***	–	–
ln $(DBC)_t$	–	–	0.388***	–
ln $(DPC)_t$	–	–	–	0.225***
R-square	0.434	0.548	0.378	0.337
Adjusted R-square	0.421	0.538	0.365	0.323
F-statistics	34.562***	54.685***	27.441***	22.967
11B: *F*-test for model specification				
Pooled vs. fixed effect	119.245***	78.625***	14.015***	27.258***
Pooled vs. random effect	121.012***	201.325***	17.662***	77.358***
Fixed vs. random effect	1.812	0.892	1.045	0.745
11C: Hausman test for model specification				
χ^2-Statistics	−0.625	−1.014	−1.201	−0.352

Note:
*** Significance at 1% level.
* Significance at 10% level.

Table 10
Pooled fixed effect regression test dependent variable: ln $(EC)_t$.

Variables	Pooled fixed effect (1)	Pooled fixed effect (2)	Pooled fixed effect (3)	Pooled fixed effect (4)
Constant	5.647***	4.522***	6.017***	5.894***
ln $(GDPPC)_t$	0.021	0.104**	−0.014	−0.006
ln $(FDI)_t$	0.016*	0.010**	0.018***	0.015***
ln $(RPRICES)_t$	−0.013	−0.004	−0.012	−0.016
ln $(M2)_t$	−0.009	–	–	–
ln $(LL)_t$	–	0.162***	–	–
ln $(DBC)_t$	–	–	−0.051*	–
ln $(DPC)_t$	–	–	–	−0.036*
R-square	0.975	0.978	0.976	0.976
Adjusted R-square	0.968	0.972	0.968	0.968
F-statistics	127.798***	147.601***	130.810***	131.015***

Note:
*** Significance at 1% level.
** Significance at 5% level.
* Significance at 10% level.

Fixed effects model captures all effects which are specific to particular individual countries and do not vary over time. The results of fixed effect model are given in Table 10.

The result shows that in Table 10, column 1, only FDI has a significant and positive impact on increasing energy demand in SAARC region; however, in column 11, GDP per capita, FDI along with liquid liability has a positive impact on increasing energy requirements in the region. The impact of financial development indicators i.e., DBC and BPC on energy consumption has been disappeared in column 111 and 1 V respectively, where both FD proxies has a significant negative impact on energy demand in SAARC region. The SAARC countries ought to accentuate on policies that inspire effective banking system reforms that would lead to an efficient financial system intended at providing sufficient loan and credit supplies to consumers or investors to encourage economic growth while at the same time fulfilling their demand for energy [51]. The results of usual diagnostic tests indicate that adjusted *R*-square has quite high value showing strong relationship between the variables. Incorporating for country effects causes *R*-square to increases minimum 97.5 percent to maximum 97.8 percent respectively. Random effect model captures both country and time effects. The results are given in Table 11.

The results show that both relative prices and FD indicators have a significant and positive impact on energy demand in SAARC region, as shown in Table 11, column (i) and column (ii) respectively. In column (iii), except relative prices; all three variables i.e., GDP per capita, FDI and DBC has a significant positive impact on energy consumption in that region which implies that selected SAARC countries are energy dependent, therefore, energy policy that aims to conserve energy consumption will slow down economic performance. The ADB [2] stresses on ensuring increased energy supply in South Asia for stabilizing one the fastest growth in the world. Ensuring cost effective energy for all amidst ever-increasing oil prices, and minimizing pollution of the local and global environment present enormous challenges to South Asia. Finally, FDI, Prices, and DPC have positive impact on energy consumption implying increased energy consumption encouraging more economic and investment activities. This calls for financial services that also call for a greater financial development in the region [46]. After incorporating for both country effects and time effects, adjusted lies in between minimum 33.7 percent to maximum 54.8 percent.

To compare the pooled OLS model with the fixed effect and random effect model, the results in Table 11, panel B, appears to indicate that the fixed effect analysis is better than the pooled OLS model. However, Random effect model is not suitable than the fixed effect model; therefore, we can conclude that the energy and its determinants in the five selected SAARC countries is apparently influenced by country effects only. To confirm the results of Table 11, panel B, another test conducting for model specification i.e., Hausman test, in Table 11, panel C. The results show that as comparing the fixed effects model with the random effects model, the Hausman test indicates that the fixed effect model is a better choice for the analysis, as shown the value of Hausman test lies in between -1.201 and -0.352 which designates insignificance level.

5. Conclusion

The objective of the study is to analyze the impact of GDP per capita, relative prices, FDI and different proxies of financial development (FD) i.e., M2, LL, DBC and DPC (each FD proxy separately regressed on dependent variable) on energy consumption (EC) in selected SAARC countries over a period of 1975–2011. This study uses different panel data techniques i.e., panel cointegration, pooled OLS, fixed effects model and random effects model to examine the energy – growth nexus including FDI, relative prices and financial development indicators in SAARC region. In addition, two model specification tests i.e., *F*-statistic and Hausman test (statistics) are used to evaluate different possibilities i.e., whether pooled OLS model is between than fixed effect or random effect model; or fixed effect model is better than random effect model etc. The results of Pedroni cointegration test indicate that variables are cointegrated and have a long-run relationship. Pooled OLS results on average indicate that except GDP per capita, remaining variables i.e., relative prices, financial development proxies and FDI have a significant and positive impact on energy consumption in SAARC region. Analysis of fixed effect model indicate that, on average, most of the independent variables, except relative prices, significantly impact energy demand in SAARC region. The results confirm the prevalence of energy led growth, energy led FDI, and energy led FD hypothesis in the region. This implies that financial depth and growth catalyst each other. The growth of the real sector significantly impacts development of the financial sector [10]. The study confirms through random effect model that all variables significantly impact energy consumption in SAARC region implying more formidable challenges than ever to SAARC countries requiring strong policy measures to guard against them [28]. Our results confirm impact of FDI on energy demand in SAARC region indicating inflow of advanced technologies as consequences of FDI and thereby escalation of economic growth and energy consumption. Model specification test shows that the fixed effect model is thought of as the best model to scrutinize the relationship between the variables.

The analysis of this study indicates that measures such as appropriate legal frameworks, increased investor information and corporate governance resulting in a strengthened financial sector may further signify the impact of FDI on economic growth on SAARC region. Energy infrastructure, an imperative for economic growth, requires such an energy policy that may not only maintain a boosted economic growth but also a sustainable economic development in the SAARC region [38]. Broad money supply, liquid liabilities, domestic credit to banking sector, and domestic credit to private sector as share of GDP, proxies for financial development, increase energy demand in SAARC region, therefore, ask for a tight examination for numerous reasons. Emerging economies with continuously developing financial markets should not see rising income as the only influencing variable for increase in energy demand. Any energy demand estimate in such economies without considering financial development probably would fail to provide accurate estimate and would unfairly interfere in conservation policies [21]. Authorities may adopt two prong strategies to increase investment in energy infrastructure on one hand and encourage R&D in green technology on other hand. While the former would ensure sufficient energy supply for financial sector and economic development, the latter would aim at exercising proper soil conservation and durable farming practices in order to reduce the consumption of fossil fuels. By doing so, environmental problems such as carbon dioxide emissions can be minimized without affecting economic growth and financial sector development [51]. Further, financial sector may take new approach to catalyst capitalization process to raise economic growth b distributing financial resources to viable, cost effective, and profit oriented projects [31]. Greater financial integration coupled with strengthened financial market can support to better intermediate Asia's vast savings within the region to narrow down the infrastructure gap [3]. Governments should build up the ongoing transformation agenda predominantly on energy infrastructure to generate adequate energy supply. This can be done through service availability, affordability, and accessibility [14]. Even the increasing inflow of FDI in the SAARC region is low in volumes. Therefore, suitable measures must be initiated to attract more FDI into the region [15]. Energy provision is vital to the development agenda in SAARC region as the promoter for change

for a better future. Globalization has opened new opportunities of interdependence in the energy arena in the SAARC region, literally translating into internationalization with foreign investment funds, energy trading and mutual cooperation in technology transfer [16]. SAARC countries should take extra caution in providing the essential environment and infrastructure that must precede lead financial development policy in the region.

For the society's perspective, the following knowledge should be shared with the states i.e.,

- *Domestic energy policies:* Governments should have to formulate and execute of their domestic energy policies by the support of the international community for capacity building and knowledge transfers for developing countries.
- *Sustainable development:* The increased use of renewable energy sources, integrating energy considerations in socio-economic programmes, establishing an appropriate enabling environment conducive to attracting foreign direct investments, optimizing the efficient use of fossil fuels, enhancing international cooperation and encouraging public-private partnerships with a view to advancing energy for sustainable development in their regions.
- *Research and developmental activities:* Sustaining research and developmental activities, including bilateral and multilateral cooperation in the research and development in the SAARC region.
- *Challenges of globalization: A*s globalization progressively fronts to higher environmental and social standards of FDI, SAARC governments need to regulate their own policies to fit into the evolving world standards.

The key policy measures are thus to advance in the financial liberalizations, economic reforms and energy supplies which would be increase in the domestic absorptive capacity of the fruits of FDI in the regions.

Appendices A

Panel unit root tests

Panel unit root tests could be considered as an extension of the univariate unit root test. The LLC test is based on the pooled panel data as follows [26]

$$\Delta y_{it} = \rho y_{it-1} + \alpha_0 + \sigma_t + \sigma_i + \theta_t + \varepsilon_{it} \tag{A1}$$

where ρ, α_0, σ are coefficients, α_i is individual specific effect, θ_t is time specific effect.

According to Levin and Lin [26], the LLC test could be conducted by the following steps. In step1, subtract the cross-section average from data;

$$\bar{y} = 1/N \sum_{i=1}^{N} y_{it} \tag{A2}$$

In step 2, an ADF test is applied to each individual series and normalizes the disturbance. The ADF model could be expressed as;

$$\Delta y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{P_i} \delta_{ij} \Delta y_{i,t-j} + \alpha_i + \varepsilon_{it} \tag{A3}$$

Maddala and Wu [29] argued that this is equivalent to perform two auxiliary regressions of Δy_{it} and $y_{i,t-1}$ on the remaining variable in Eq. (2). Let the residuals from these two regression be $\hat{e}_{i,t}$ and $\hat{V}_{i,t-1}$ respectively. The, regress $\hat{e}_{i,t}$ on $\hat{V}_{i,t-1}$.

$$\hat{e}_{i,t} = \rho_i \hat{V}_{i,t-1} + \varepsilon_{it} \tag{A4}$$

Levin and Lin [26] suggest the following normalization to control the Heteroskedasticity in error.

$$\hat{\sigma}_{ei}^2 = \frac{1}{T - P_i - 1} \sum_{t=p+2} (\hat{e}_{i,t} - \hat{\rho}_i - \hat{V}_{i,t-1})^2$$

$$\tilde{e} = \frac{\hat{e}_{i,t}}{\hat{\sigma}_{ei}}$$

$$\tilde{v}_{i,t-1} = \frac{\tilde{v}_{i,t-1}}{\hat{\sigma}_{ei}}$$

In the next step, the LLC test statistic could be obtained from the following regression:

$$\tilde{e}_{i,t} = \rho \tilde{v}_{i,t-1} + \tilde{\varepsilon}_{i,t}$$

The t-statistic for testing $\tilde{o} = 0$ is given by

$$t_\delta = \frac{\hat{\delta}}{\mathrm{STD}(\hat{\delta})}$$

where

$$\hat{\delta} = \frac{\sum_{i=1}^{N} \sum_{t=2+p}^{T} \hat{v}_{t-1} \hat{e}_{it}}{\sum_{i=1}^{N} \sum_{t=2+p} \hat{v}_{it-1}^2} \tag{A5}$$

The IPS test is based on the mean value of individual ADF statistics or t-bar [20]. The IPS test provides separate estimation for each i section, allowing different specifications of the parametric values, the residual variance and the lag lengths. Their model is given by:

$$\Delta Y_{i,t} = \alpha_i + \rho_i Y_{i,t-1} + \sum_{k=1}^{n} \varphi_k \Delta Y_{i,t-k} + \delta_i t + u_{it} \tag{A6}$$

The null hypothesis and the alternative hypothesis are formulated as:

$$H_0 : \rho_i = 0$$

$$H_A : \rho_i < 0$$

for at least one i

Thus, the null hypothesis of this test is that all series are non-stationary process under the alternative that fraction of the series in the panel are assumed to be stationary. IPS also suggested a group mean Lagrange multiplier test for testing panel unit roots.

Maddala and Wu [29] attempted to improve to the same degree the drawbacks of all previous tests by proposing a model that could also be estimates with unbalanced panels. Basically, Maddala and Wu are in line with the assumptions that a heterogeneous alternative is preferable, but they disagree with the use of the average ADF statistics by arguing that it is not the most effective way of evaluating stationary.

The panel data unit root test has two main methods. One is based on the same root, including the LLC test method proposed by Levin et al. [27], Breitung test demonstrated by Breitung [9] and Hardi test put forward by Hardi [17]. The other is the unit root test for different unit roots, including the IPS test proposed by Im et al. [20] as well as the ADF and PP tests put forward by Maddala and Wu [29]. To overcome the deviation created by single methods, this paper adopts the tests of LLC, Fisher-ADF and Fisher-PP for unit root analysis.

Panel cointegration test

There are three major methods of cointegration test i.e., the Pedroni test proposed by Pedroni [36], Kao test demonstrated by Kao [23] and Johansen panel cointegration test put forward by Maddala and Wu [29]. In this study, we selected Johansen panel cointegration test because of the comparatively more research variables and comparatively longer time series as well considering the space limit.

Panel least square

The common constant method (Pooled LS method) of estimation present results under the principal statement that there is no difference among the data matrices of the cross-sectional dimension (N). In other words, the hypothesis is useful that the data set is a priori homogenous. However, this case is quite restrictive; that's why, we include the fixed and random effects in the method of estimation (see, [5]).

Panel fixed effect

In the fixed effects method the constant is treated as group specific. This means that the model allows for different constants for each group. The fixed effects estimator is also known as the least-squares dummy variables (LSDV) estimator because in order to allow for different constants for each group, it includes a dummy variable for each group.

Panel random effect

An alternative method of estimation is the random effects model. The difference between the fixed effects and the random effects method is that the latter handles the constants for each section not as fixed but as random parameters. Hence, the variability of the constant for each section comes from the fact that:

$$a_i = a + v_i \tag{A7}$$

where, v_i is standard random variable with a zero mean:

The random effects model therefore takes the following form:

$$\begin{aligned} Y_{it} &= (a+v_i)+\beta_1 X_{1it}+\beta_2 X_{2it}+\ldots\ldots+\beta_k X_{kit}+u_{it} \\ Y_{it} &= a+\beta_1 X_{it}+\beta_2 X_{2it}+\ldots\ldots\ldots+\beta_k X_{kit}+(v_i+u_{it}) \end{aligned} \tag{A8}$$

The random effects model has two advantages: it has fewer parameters to estimate compared to the fixed effects method and allows for additional explanatory variables that have equal value for all observations within a group (i.e., it allows using dummies).

F-test for model specification (pooled OLS vs fixed effects)

Before assessing the validity of the fixed effects method, we need to apply tests to check whether fixed effects i.e., different constants for each group, should indeed be included against the simple common constant OLS method. The null hypothesis is that all the constants are the same (homogenous) and therefore the common constant method is applicable:

$$H_0 : a_1 = a_2 = \ldots a_N \tag{A9}$$

Rejection or acceptance of the null hypothesis depend on the value of F-statistic i.e. if F-statistical is bigger than the F-critical then we reject the null hypothesis.

The F-statistic is

$$F = \frac{R^2_{\mathrm{FE}} - R^2_{\mathrm{CC}}/(N-1)}{(1-R^2_{\mathrm{FE}})/(\mathrm{NT}-N-K)} \tag{A10}$$

where R^2_{FE} coefficient of determination of the fixed effects is model and R^2_{CC} is the coefficient of determination of the common constant method. If F-statistical is bigger than the F-critical then we reject the null hypothesis.

F-test (pooled OLS vs random effects)

The F-statistic is:

$$F = \frac{R^2_{\mathrm{RE}} - R^2_{\mathrm{CC}}/(N-1)}{(1-R^2_{\mathrm{RE}})/(\mathrm{NT}-N-K)} \tag{A11}$$

where R^2_{FE} coefficient of determination of the fixed effects is model and R^2_{CC} is the coefficient of determination of the common effect method. If F-statistical is bigger than the F-critical then we reject the null hypothesis.

F-test (fixed effects vs random effects)

The F-statistic is

$$F = \frac{R^2_{\mathrm{RE}} - R^2_{\mathrm{FE}}/(N-1)}{(1-R^2_{\mathrm{RE}})/(\mathrm{NT}-N-K)} \tag{A12}$$

where R^2_{FE} coefficient of determination of the fixed effects is model and R^2_{RE} is the coefficient of determination of the random effect method. If F-statistical is bigger than the F-critical then we reject the null hypothesis.

Hausman test for model specification (fixed effects vs random effects)

The Hausman test is formulated to assist in making a choice between the fixed effects and random effects approaches. Hausman (1978) adapted a test based on the idea that under the hypothesis of no correlation, both OLS and GLS are consistent but OLS is inefficient, while under the alternative OLS is consistent but GLS is not. More specifically, Hausman assumed that there are two estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ of the parameter vector β and he added two hypothesis-testing procedures. Under null hypothesis, both estimators are consistent but $\hat{\beta}_0$ is inefficient, and under alternative hypothesis, $\hat{\beta}_1$ is consistent and efficient, but $\hat{\beta}_1$ is inconsistent.

For the panel data, the appropriate choice between the fixed effects and the random effects methods investigates whether the regressors are correlated with the individual effect. The advantage of the use of the fixed effects estimator is that it is consistent even when the estimators are correlated with the individual effects. The Hausman test uses the following test statistic:

$$H = (\hat{\beta}^{\mathrm{FE}} - \hat{\beta}^{\mathrm{RE}})'[\mathrm{Var}(\hat{\beta}^{\mathrm{FE}}) - \mathrm{Var}(\hat{\beta}^{\mathrm{RE}})]^{-1}(\hat{\beta}^{\mathrm{FE}} - \hat{\beta}^{\mathrm{RE}})\ldots\ldots x^{2(k)} \tag{A13}$$

If the value of the statistic is large, then the difference between the estimates is significant, so we reject the null hypothesis that the random effects model is consistent and we use the fixed effects estimators. In contrast, a small value of the Hausman statistic implies that the random effects are more appropriate.

The random effect model could be written as:

$$\mathrm{EC}_{it} = \alpha + n_i + \beta_1 \mathrm{GDPPC}_{it} + \beta_2 \mathrm{RPRICES}_{it-1} + \beta_3 \mathrm{FDI}_{it-1} + \beta_4 \mathrm{FD}_{it-1} u_{it} \tag{A14}$$

where n_i is group specific random element.

Hausman test for model specification (fixed effects vs random effects)

The Hausman test is formulated to assist the choice between the fixed effects and random effects approaches. Hausman (1978) adapted a test based on the idea that under the hypothesis of no correlation, both ordinary least square (OLS) and generalized least square (GLS) are consistent but OLS is inefficient, while under the alternative OLS is consistent but GLS is not. More specifically, Hausman assume that there are two estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ of the parameter vector β and he adds two hypothesis-testing procedures. Under null hypothesis, both estimators are consistent but $\hat{\beta}_0$ is inefficient, and under alternative hypothesis, $\hat{\beta}_1$ is consistent and efficient, but $\hat{\beta}_1$ is inconsistent.

For the panel data, the appropriate choice between the fixed effects and the random effects methods investigates whether the regressors correlate with the individual effect. The advantage of the use of the fixed effects estimator is that it is consistent even when the estimators are correlated with the individual effects. The Hausman test uses the following test statistic:

$$H = (\hat{\beta}^{FE} - \hat{\beta}^{RE})'[\mathrm{Var}(\hat{\beta}^{FE}) - \mathrm{Var}(\hat{\beta}^{RE})]^{-1}(\hat{\beta}^{FE} - \hat{\beta}^{RE}) \ldots\ldots x^{2(k)} \tag{A15}$$

If the value of the statistic is large, then the difference between the estimates is significant. So, we reject the null hypothesis that the random effects model is consistent and we use the fixed effects estimators. In contrast, a small value of the Hausman statistic implies that the random effects are more appropriate.

The random effect model can be written as:

$$\begin{aligned}\ln(\mathrm{EC})_{it} = \; & \alpha + n_i + \beta_1 \ln(\mathrm{GDPPC})_{it} + \beta_2 \ln(\mathrm{RPRICES})_{it} + \beta_3 \ln(\mathrm{FDI})_{it} \\ & + \beta_4 \ln(\mathrm{FD})_{it} + u_{it}\end{aligned} \tag{A16}$$

where n_i is a group specific random element.

References

[1] ADB. Financial sector in South Asia: recent developments and challenges. Asian Development Bank, South Asia Economic Report – (Manila, Philippines: Asian Development Bank, 2009); 2009.

[2] ADB. Energy Trade in South Asia: Opportunities and Challenges. Mandaluyong City, Philippines: Asian Development Bank; 2011.

[3] ADB. Asian economic integration monitor. Mandaluyong City, Philippines: Asian Development Bank; 2012.

[4] Ansari N., Khan T. FDI and regional economic integration in SAARC region: problems and prospects. Online at ⟨http://mpra.ub.uni-muenchen.de/32365/⟩; 2011 [accessed 17.10.12].

[5] Asteriou D, Stephen GH. Applied econometrics: a modern approach using EViews and microfit. New York: Palgrave Macmillan; 2007.

[6] Basu P, Chakraborty C, Reagle D. Liberalization, FDI, and growth in developing countries: a panel cointegration approach. Econ Inq 2007;41(3):510–6.

[7] Belaisch A, Zanello A. Deepening financial ties. Finance Dev 2006;43(2): 16–9.

[8] Bekhet HA, Othman NS. Causality analysis among electricity consumption, consumer expenditure, gross domestic product (GDP) and foreign direct investment (FDI): case study of Malaysia. J Econ Int Finance 2011;3(4): 228–35.

[9] Breitung J. Nonstationary panels, panel cointegration, and dynamic panels. Adv Econ 2000;15(2):161–78.

[10] Calderón C, Liu L. The direction of causality between financial development and economic growth. J Dev Econ 2003;72(1):321–34.

[11] Chary SR, Bohara AK. Carbon emissions, energy consumption and income in SAARC countries. South Asia Econ J 2010;11(1):21–30.

[12] Chatterjee P. Economic integration and development in South Asia: a tale of unfulfilled promises. Kalyani University, West Bengal, India. Online available at: ⟨http://theinclusive.org/economic-integration-and-development-in-south-asia-a-tale-of-unfulfilled-promises⟩; 2012 [accessed 17.11.12].

[13] Chtioui S. Does economic growth and financial development spur energy consumption in Tunisia? J Econ Int Finance 2012;4(7):150–8.

[14] Dantama YU, Abdullahi YZ, Inuwa N. Energy consumption – economic growth nexus in Nigeria: an empirical assessment based on ARDL bound test approach. Eur Sci J 2012;8(12):141–57.

[15] EXIM. SAARC: An Emerging Trade Bloc. Export-Import Bank of India, Occasional Paper No. 123, Quest Publications. Online available at: ⟨http://www.eximbankindia.com/op/op123.pdf⟩; 2008 [accessed 03.02.13].

[16] Ghose AK. Contemporary issues in coal and energy in SAARC nations: opportunities and challenges in the background of globalization. Online available at: ⟨http://www.sari-energy.org/PageFiles/What_We_Do/activities/advanced_coal_managment_dec-2009/Presentations/Course_Material.pdf⟩; 2012 [accessed 20.02.13].

[17] Hardi K. Testing for stationarity in heterogeneous panel data. Econom J 2000;3 (2):148–61.

[18] Hossain MS. Multivariate granger causality between economic growth, electricity consumption, exports and remittance for the panel of three SAARC countries. Global J Manag Bus Res 2012;12(4):41–54.

[19] Hossain MS, Saeki C. Does electricity consumption panel granger cause economic growth in South Asia? Evidence from Bangladesh, India, Iran, Nepal, Pakistan and Sri-Lanka Eur J Soc Sci 2011;25(3):316–28.

[20] Im KS, Peseran MH, Shin Y. Testing for unit roots in heterogeneous panels. J Econom 2003;115(2):53–74.

[21] Islam F, Shahbaz M, Ahmed AU. Financial development and energy consumption nexus in Malaysia: a multivariate time series analysis. Econ Model 2013;30(1):435–41.

[22] Jayanthakumaran K, Lee SW. Evidence on the convergence of per capita income: a comparison of founder members of the association of South East Asian nations and the South Asian association of regional cooperation. Pac Econ Rev 2013;18:108–21.

[23] Kao C. Spurious regression and residual-based tests for cointegration in panel data. J Econom 1999;90(1):1–44.

[24] Kreishan FM, Sami J. FDI and export-led growth in Jordan: evidence from cointegration and causality test. College of Business, Hospitality & Tourism Studies; 2012.

[25] Lamberte MB. An overview of economic cooperation and integration in Asia. Online available at: ⟨http://aric.adb.org/pdf/ten_years_after/Lamberte%20-ADB%20%282005%29%20An%20overview%20of%20the%20economic%20cooperation%20and%20integration%20in%20Asia.pdf⟩; 2005 [accessed 21.02.13.].

[26] Levin A, Lin CF. Unit root tests in panel data: asymptotic and finite-sample properties. Mimeo: University of California, San Diego; 1992.

[27] Levin A, Lin CF, Chu CS. Unit root tests in panel data: asymptotic and finite sample properties. J Econom 2002;108:1–24.

[28] Liu LG, Chow K, Li U. Determinants of foreign direct investment in East Asia: did China crowd out FDI from her developing East Asian neighbours? China World Econ 2007:70–88.

[29] Maddala G, Wu S. A comparative study of unit root tests with panel data and a new simple test. Oxf Bull Econ Stat 1999;61(1):631–52.

[30] Malik SM, Janjua Y. The impact of recent financial crisis on economic growth and youth employment in South Asia. Online available at: ⟨http://ssrn.com/abstract=1761129⟩ or http://dx.doi.org/10.2139/ssrn.1761129; 2011 [accessed 17.02.13].

[31] Mehrara M, Musia M. Energy consumption, financial development and economic growth: an ARDL approach for the case of Iran. Int J Bus Behav Sci 2012;2(6):92–9.

[32] Metzger M. Trends in Financial market development in South Asia. New Delhi, India. Online available at: ⟨http://www.icrier.org/pdf/Martina%20Metzger-Paper.pdf⟩; 2010 [accessed 26.12.12.].

[33] Nasir ZM, Hassan A. Economic freedom, exchange rates stability and FDI in South Asia. In: Proceedings of the 27th AGM conference, 13–15th December, 2011, Pakistan society of development economists, Pakistan Institute of Development Economics. Quaid-i-Azam University Campus, Islamabad, Pakistan; 2011.

[34] Nguyen M, Skully M, Perera S. Market power, revenue diversification and bank stability: evidence from selected South Asian countries. J Int Financial Mark., Inst Money 2012;22(4):897–912.

[35] Pakistan Economic Survey. Chapter 14: energy. Islamabad, Pakistan: Ministry of Finance, Federal Bureau of Statistics; 2012–2013. p. 187–202.

[36] Pedroni P. Critical value for cointegration tests in heterogeneous panels with multiple regressors. Oxf Bull. Econ. Stat. 1999;61(1):653–70.

[37] Perera A, Wickramanayake J. Financial integration in selected South Asian countries. South Asian J Global Bus Res 2012;1(2):210–37.

[38] Pradhan RP. Energy consumption- growth nexus in SAARC countries: Using Cointegration and error correction model. Mod Appl Sci 2010;4(4):74–90.

[39] Pradhan RP. Government spending and economic growth in SAARC: evidence from panel cointegration. Int J Econ Policy Emerg Econ 2011;4(1):78–94.

[40] Rana PB, Wai-Mun C. Strengthening economic linkages between South Asia and East Asia: the case for a second round of "Look East" policies. RSIS working paper series 253, p. 1–49. Online available at: ⟨http://www.rsis.edu.sg/publications/WorkingPapers/WP253.pdf⟩; 2013 [accessed 17.02.13.].

[41] SAPANA. Trade, Tariffs, and Customs in South Asia. Lahore, Pakistan: South Asian Policy Analysis Network (SAPANA); 2006.

[42] SAARC report. Area of Cooperation: Energy. SAARC Secretariat, Kathmandu, Nepal. Online available at: ⟨http://saarc-sec.org/areaofcooperation/cat-detail.php?cat_id=55⟩; 2009 [accessed 15.08.14.].

[43] SAWTEE. Energy cooperation in South Asia: Prospects and Challenges. Kathmandu, Nepal: Economics and Environment (SAWTEE); 2010 (South Asia Watch on Trade).

[44] SEC. SAARC initiative on regional cooperation in energy sector. SAARC energy centre. In: Proceedings of the 11th Petro India conference New Delhi, India, December 11; 2012.

[45] SEC. SAARC energy data book 2001–2010. Islamabad, Pakistan: SAARC energy Centre, 2013. Online available at: http://www.saarcenergy.org/Resources/EnergyDataBank.aspxc (accessed on 15th August, 2013).

[46] Shahbaz M, Lean HH. Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia Energy Policy 2012;40(1):473–9.

[47] Shahbaz M, Khan S, Tahir MI. The dynamic link between energy consumption, economic growth, financial development and trade in china: fresh evidence from multivariate framework analysis. Online available at: 〈http://mpra.ub.uni-muenchen.de/42974/〉; 2012 [accessed 05.01.13.].

[48] Shankar PU. Energy cooperation in South Asia: commitments and new dimensions. SAARC chamber of commerce and industry. Ministry of Power, Government of India; 2012.

[49] SHRDC. SAARC human resource development centre, Islamabad, Pakistan; 2012.

[50] SRETS. SAARC regional energy trade study, SAARC secretariat, Katmandu, Nepal; 2012.

[51] Tang CF, Tan BW. The linkages among energy consumption, economic growth, relative price, foreign direct investment, and financial development in Malaysia. Qual Quant. Online available at: 〈http://link.springer.com/article/10.1007%2Fs11135-012-9802-4〉; 2012 [accessed 17.01.13].

[52] Tang CF. Electricity consumption, income, foreign direct investment, and population in Malaysia. J Econ Stud 2009;36(4):371–82.

[53] UNCTAD. Regional integration and foreign direct investment in developing and transition economies. In: Proceedings of the United Nations conference on trade and development, Geneva.Working Paper Series No. 06/12. Fiji National University, Fiji; 2012.

[54] World Bank. World development indicators. The World Bank, Washington, DC, USA. Online available at: 〈http://data.worldbank.org/data-catalog/world-development-indicators/WorldBank-2011〉; 2012 [accessed 01.07.12.].

[55] Zeren F, Koc M. The nexus between energy consumption and financial development with asymmetric causality test: new evidence from newly industrialized countries. Int J Energy Econ Policy 2014;4(1):83–91.